

**AMENDMENTS TO THE SPECIFICATION**

Please amend the specification as follows:

Please amend the paragraph at page 1, beginning on line 10 to read as follows:

On VLSI and ULSI semiconductor chips, ~~Al~~ Al and alloys of ~~Al~~ Al are used for conventional chip interconnect/wiring material. However, more recently copper and alloys of copper have been developed as chip interconnects material. The use of copper and copper alloys results in improved device performance when compared to Al and its alloys.

Please amend the paragraph at page 3, beginning at line 3 to read as follows:

The slurry compositions of the present invention comprise:

- A. about 0.01% by weight to about 50% by weight of abrasive particles;
- B. about 0.01% to about 50% by weight of an oxidizer;
- C. at least about ~~100~~ 500 ppm of quaternary ammonium hydroxide;
- D. an acid having a pKa of about 2.5 or lower in an amount sufficient to provide an acidic pH;
- And F. E water.

Please amend the paragraph beginning at page 4, line 25 to read as follows:

The term "alkyl" refers to straight or branched chain unsubstituted hydrocarbon groups of 1 to 20 carbon atoms, preferably 1 to 8 carbon atoms. The expression "lower alkyl" refers to alkyl groups of 1 to 4 carbon atoms. Examples of suitable alkyl groups include methyl, ethyl, ~~propyl~~ propyl and butyl. Typical quaternary ammonium hydroxides are tetraalkylammonium and aryltrialkylammonium hydroxides such as tetramethylammonium hydroxide (TMAH), tetraethylammonium hydroxide, tetrapropylammonium hydroxide, tetrabutylammonium hydroxide (TBAH), ethyltrimethylammonium hydroxide, diethyldimethylammonium hydroxide and benzyltrimethylammonium hydroxide.

Please amend the paragraph beginning on page 7, line 21 to read as follows:

Accordingly the present invention is suitable for polishing a semiconductor substrate comprising of (i) a ferromagnetic metal layer (ii) a metal from ~~group 3d~~ period 4d or 5d of the periodic table (for example ruthenium, iridium, palladium, platinum, etc.) (iii) a conducting metal (such as copper, aluminum) (iv) an associated barrier layer (for example, tantalum, tantalum nitride, titanium, titanium nitride cobalt based barrier layers and/or tungsten based barrier layers) and (iv) an associated dielectric layer (such as silicon dioxide). Examples of such applications include but not restricted to manufacturing of capacitors which have relatively high dielectric constants, formation of copper damascene interconnects (with or without involving the noble metals or the ferromagnetic materials), and processing of hard disk drives.

Please amend the paragraph beginning on page 7, line 30 to read as follows:

As such, the CMP composition contacts a variety of different materials, copper, the dielectric or capping layer, as well as the wafer backside, which is generally a thin layer of oxidized silicon as a minimum. Accordingly, the polishing composition must be selective to remove the metal as ~~contracted~~ contrasted to the dielectric.

Please amend the paragraph beginning at page 8, line 11 to read as follows:

The following composition is made by ~~missing~~ mixing the following components in the concentrations listed bellow. The pH of the slurry is 2.5:

	Concentrations in ppm
PoliEdge 2001 silica	128571
Benzotriazole	6500
Tetrabutyl ammonium hydroxide ( <u>TBAH</u> )	4000
Phosphoric acid	4488
Deionized water	Balance

Please amend the paragraph beginning at page 9, line 13 to read as follow:

Film	Removal Rate (RR) ( $\text{\AA}/\text{min}$ )
Cu	304
Ta	1024
TEOS	1230
<del>FeNi</del> <u>Fe-Ni</u>	2008
Ru	251

Please amend the paragraph beginning at page 9, line 18 to read as follows:

A 8" patterned wafer containing ~~9000A~~ 9000 $\text{\AA}$  deep trenches patterned inside a TEOS dielectric. The trenches are filled with a metallization stack consisting of ~~200A~~ 200 $\text{\AA}$  Ta/~~400A~~ 100 $\text{\AA}$  Ru/~~250A~~ 250 $\text{\AA}$  Fe-Ni/~~400A~~ 100 $\text{\AA}$  Ru/~~9000A~~ 9000 $\text{\AA}$  Cu. The copper film deposited on the regions outside the trenches is first removed using a copper CMP process using a slurry with Cu:Ta removal rate selectivity of more than 100. This results in a wafer with copper restricted to the trenches. The remaining wafer is still covered with the Ta/Ru/~~Ni~~Fe-Ni/Ru metallization layer. The slurry described in example 1 along with the hydrogen peroxide dilution also described in example 1 is used to remove these metallic layers. CMP polish parameters except for the polish time are identical as in example 1.

Please amend the paragraph beginning at page 10, line 10 to read as follows:

	After copper CMP Step	45 second polish using slurry in Example 1	90 second polish using slurry in Example 1
Center Die	1625Å	1994Å	176Å
Mid-Die	1716Å	1940Å	294Å
Edge Die	2408Å	2397Å	786Å

Please amend page 11, line 1 through page 13, line 4 to read as follows:

Example 4:

Slurry samples are prepared containing 2500 ppm phosphoric acid, 500 ppm nitric acid 10% Poliedge 2001 silica and a base to bring the pH up-to-2. Different bases used for the slurry formulations are listed in the table below. The samples are aged in an oven at 50°C for 7 days. From the table it is apparent that the quaternary ammonium hydroxides such as tetrabutyl ammonium hydroxide (TBAH) and tetramethyl ammonium hydroxide (TMAH) are useful in improving the colloidal stability of the slurries in acidic pH.

Base	pH	<u>Colloidal Silica Particle Size (nm) 7 days at 50°C</u>
Ammonia	1.99	88.4
KOH	1.97	88.5
No base	1.53	84.1
TBAH	1.99	75
TMAH	1.99	77.5

## Example 5:

The following compositions are fabricated:

Example	Composition (ppm)								
	PoliEdge 2001 Silica	Benzotriazole	TBAH	Phosphoric Acid	Nitric Acid			pH	
6A	128571	5000	6480	500	2500			2.54	
6B	128571	1000	6091	500	2500			2.48	

The balance of the above compositions is water.

These slurries are diluted with 30% hydrogen peroxide and water in the volume ratio 70 parts slurry: 29 parts water: 1 part of 30% hydrogen peroxide. Cu, Ta, TEOS, Ru and ~~Re~~ Fe-Ni films on 8" wafer substrates are polished using the protocol described in Example. The following table summarizes the removal rate data.

EXAMPLE	6A	6b
Cu	418 $\text{\AA}/\text{min}$	355 $\text{\AA}/\text{min}$
Ta	1161 $\text{\AA}/\text{min}$	1005 $\text{\AA}/\text{min}$
TEOS	1139 $\text{\AA}/\text{min}$	1094 $\text{\AA}/\text{min}$
Ru	542 $\text{\AA}/\text{min}$	744 $\text{\AA}/\text{min}$
<del>Fe-Ni</del> Fe-Ni	1108 $\text{\AA}/\text{min}$	770 $\text{\AA}/\text{min}$

## Example 6:

The slurry described in Example 1 is mixed with de-ionized water and 30% hydrogen peroxide in different ratios. These formulations are subsequently used to polish copper films with 6" diameter. The polishing protocol is the same as described in Example 1.

As seen from this example, the copper removal rates can be tuned to whatever desired level by simply changing hydrogen peroxide amount added at the time of polishing. High copper removal rates are possible using this method which can potentially allow only compositions having the same components but differing in the relative concentration of the oxidizing agent to be used for entire polishing operation including copper overburden removal step and the barrier/sandwich (e.g., Ta, ferromagnetic metal, and period 4d and 5d inter-layer exchange coupling metal) removal layer step. If a tighter control of topography is needed, the same slurry can be used at two different concentrations during these stages. In copper overburden removal, peroxide concentration may be maintained high to allow high copper rates and thus high throughout. As the copper overburden is cleared, peroxide concentration may be reduced to reduce copper removal rates and thus making it possible to have a low final topography.